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PATENT KOKAI NO. HEI 4[1992]-141603

Int. Cl.^{5}	ID Codes	Sequence Nos. for Office Use
G 02 B 5/30		7724-2K
27/28	Z	9120-2K
G 03 B 21/00	Z	7316-2K

Application No. : Hei 2[1990]-265634

Application Date : October 3, 1990

Kokai Publication Date : May 15, 1992

No. of Inventions : 3 (Total 5 pages in Japanese original)

Examination Request : Not requested

TITLE: POLARIZING LIGHT SOURCE DEVICE, AND PROJECTION TYPE LIQUID CRYSTAL DISPLAY DEVICE USING THE SAME

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Agent: Kisaburo SUZUKI, Patent agent
Includes one other.

Amendments: There are no amendments to this patent.

[note: All names, addresses, company names, and brand names are translated in the most common manner. Japanese language does not have singular or plural words unless otherwise specified with numeral prefix or general plurality suffix. translator's note]

TITLE OF THE INVENTION: Polarized light source and projection type liquid crystal display device using the same,

CLAIMS

(1) According to a polarizing light source device that mainly consists of a light source lamp, a reflector that reflects radiated lights from said light source lamp, and a polarized light separator that takes out polarized lights from nonpolarized lights discharged from that light source device; a polarizing light source has characteristics as such that said polarized light separator consists of several sheets of panels made of almost transparent glass material or plastic and several pieces of prism; and they are arranged in such manner so the lights discharged from said light source device first enter optical planes of prisms perpendicularly; and then, pass through these at such angle that transmissivity of polarized light perpendicular to each optical plane of said several sheets of panels would be almost 100%; and then, they enter prisms again, and are discharged perpendicularly from those optical planes; and in addition, each member is arranged mutually close to each other having slight air layers between.

(2) The polarizing light source device according to the claim item 1, wherein said panels made of almost transparent glass material or plastic are formed with slightly tapered angle.

(3) According to a projection type liquid crystal display device that mainly consists of a light source device that discharges almost parallel lights, a colored light separator that separates said parallel lights to three primary colors, a liquid crystal light valve that modulates each primary color, a colored light synthesizer that synthesizes each modulated light, and a projection lens that enlarges and projects synthesized modulated lights, a projection type liquid crystal display device has characteristic as such that said light source device is the polarizing light source device of the claim item 1 or 2.

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(2) The polarizing light source device according to the claim item 1, wherein said panels made of almost transparent glass material or plastic are formed with slightly tapered angle.

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DETAILED EXPLANATION OF THE INVENTION

[Field of industrial application]

This invention relates to a polarizing light source device utilized for projection type liquid crystal display device and the like.

[Prior art]

According to conventional projection type liquid crystal display device, a method of taking out polarized lights from lights of light source is generally conducted by taking out luminous flux with high degree of polarization by entering luminous flux from a light source device directly to a polarization panel. However, according to this method, when quantity of light is increased in order to brighten a screen, temperature of polarization panel increases significantly to present problems points of requiring a high capacity cooling in order to prevent from degradation of polarization panel; and as a result, a method illustrated in Figure 2 that uses prepolarizer (21) was proposed. According to this method, almost parallel nonpolarized lights (13) from a light source device comprising a white light source (11) and parabolic reflector (12) are passed through a prepolarizer (21) comprising several plate glass panels of which incidental angle of luminous flux against each optical plane is Brewster angle and becomes luminous flux (22) from which almost all s-polarized lights are removed, and removed s-polarized lights become reflected lights (26) and are thrown away. When transmitted luminous flux (22) of which p-polarized lights are selectively transmitted through polarization panel (23) arranged nearby liquid crystal panel, they become polarized lights (24) with high degree of polarization. And therefore, quantity of s-polarized lights absorbed by polarization panel (23) becomes somewhat smaller compared to the case when luminous flux from light source device is directly entered; and therefore, cooling of polarization panel (23) becomes fairly easy. When refractive index of glass material happens to be, for instance, 1.53, Brewster angle theta (θ) becomes 56.8° according to following formula:

$$\text{theta } (\theta) = \arctan (n_1/n_0) \quad \ldots\ldots \quad (1)$$

Furthermore, n_0 shows refractive index of air 1.0; and n_1 shows refractive index of glass material 1.53. And therefore, plate glass of prepolarizers (21) are arranged so the incidental angle of luminous flux would be 56.8°.

[Subjects solved by this invention]

According to above-explained prior art that uses prepolarizer, because plate glass is arranged so the incidental angle of luminous flux would be 56.8^{O}, prepolarizers become fairly large in size; and in addition, as illustrated in the Figure 2, when they are arranged in V-letter shape in order to reduce the size, because proceeding direction of beam (25) in the glass material is folded based on Snell's law, it presents problems points of damage on luminous flux at seam portions of plate glasses. This invention solves such problem points; and its purpose is to offer a small sigh and highly efficient polarizing light source device that uses prepolarizer of small size with short optical path length and small light loss.

[Measures used to solve the subjects]

This invention's polarizing light source device mainly consists of a light source lamp, a reflector that reflects lights radiated from said light source lamp, and a polarized light separator that takes out polarized lights from nonpolarized lights discharged from that light source device; and it has characteristics as such that said polarized light separator comprises several sheets of panels made of almost transparent glass material or plastic and several pieces of prisms, and their arrangement is as such that lights discharged from said light source device would first enter optical planes of prisms perpendicularly, and then, they are passed through several sheets of panels in such manner so the transmissivity of polarized lights perpendicularly to each optical plane would be almost 100%, and then, they are again entered prisms and are discharged perpendicularly from each optical plane; in addition, each member is arranged mutually closely with slight air layers between.

[Actions]

According to above-explained constitution of this invention, when, for instance, refractive index of glass material happens to be 1.53, because Brewster angle theta (θ) would be 33.2^{O} based on refractive index 1.53 of glass material n_0 and refractive index 1.0 of air n_1 according to the formula (1), plate glasses are arranged in such manner so the incidental angle of luminous flux would be 33.2^{O}. Almost parallel lights which are discharged from light source device enter perpendicularly to the glass material of prepolarizer; and therefore, they hardly show changes in their proceeding direction, and enter optical planes of plate glasses. As they enter these optical planes always with Brewster angle, almost 100 % of p-polarized lights pass through, and part of s-polarized lights are reflected. After passing through several plate glasses, almost all s-polarized lights are reflected and almost all are discharged as p-polarized lights; and they are again passed through prisms and are discharged with hardly any changes in their

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proceeding direction. In addition, when slight tapered angle is applied to above-explained plate glasses, proceeding direction of s-polarized lights which are transmitted through repeat reflection changes to improve degree of polarization at the end.

[Examples]

Figure 1 illustrates a constitutional plane view of one example of this invention's polarizing light source. Luminous flux radiated from a white light source (11) (halogen lamp, metal halide lamp, xenon lamp, and the like) is reflected at parabolic reflector (12), and becomes almost parallel nonpolarized lights (13); and they enter a prepolarizer comprising prism (14) and several sheets of plate glasses (15). In this prepolarizer, there are air gaps which are spontaneously formed between prism (14) and plate glasses (15), and among several sheets of plate glasses (15); and in addition, optical planes of each plate glasses (14) [note: although original document states as (14), maybe a misprint of (15). translator's note] are arranged to form Brewster angle against incidental lights. And therefore, among the nonpolarized lights (13) which enter said prepolarizer, almost all p-polarized lights are transmitted while almost all s-polarized lights are reflected; and as a result, discharged lights (17) are luminous flux of p-polarized lights. Reflected lights (18) are totally of s-polarized lights, and they are discarded. In addition, because this prepolarizer is made of the same glass material as a whole when presence of slight air layers is ignored and transmitted lights (16) proceed and exit in the same direction as that of prior to entrance, loss of quantity of light should not occur at V-letter seam.

Figure 3 illustrates a plane view that shows behavior of proceeding beam in the prepolarizer. After proceeding light (33) enters optical planes of prisms (31) perpendicularly, they reach optical planes which form Brewster angle (34) against proceeding light, At that plane, almost all 100 % of p-polarized lights are transmitted; and part of s-polarized lights are reflected. Then, the lights which exit prisms are refracted according to Snell's law; and pass through air layers among prisms (31) and plate glasses (32) to reach optical planes of plate glasses (32). Because incidental angle is of also Brewster at this time, part of s-polarized lights are reflected and 100 % of p-polarized lights are transmitted in the same manner as explained above. The same is repeated at each optical plane of plate glass (32) which follows; and after passing through prism of

[illegible] discharged luminous flux, two forms of lights in which s-polarized lights which pass through each optical plane, and the ones which exit after several times of reflection at optical

planes may be considered. And therefore, as methods to increase degree of polarization of discharged lights, a method to reduce s-polarized lights which are transmitted through increase of number of plate glass sheets (32) or increase in refractive index of glass material; or a method to provide slightly tapered angle to air layer among plat glass or plate glasses to change proceeding direction of s-polarized lights after several reflections may be considered.

Figure 4 illustrates a plane view that shows behavior of proceeding light in the prepolarizer when tapered angle is applied to the plate glasses of prepolarizer. As slight tapered angle is applied to plate glass (41), incidental angle of luminous flux to optical plane of plate glass (41) may sometimes slip slightly from Brewster angle; however, it is all right to consider that transmissivity of p-polarized lights is almost 100%. Proceeding direction of slight amount of s-polarized lights which are transmitted through repeat reflection is different from the proceeding direction of p-polarized lights transmitted by affect of tapered angle; and degree of polarization of transmitted light improves at the end through application of tapered angle.

Figure 5 illustrates a constitutional diagonal view of projection type liquid crystal display device constructed by using this invention's polarizing light source device. Almost all s-polarized lights of nonpolarized lights (13) discharged from light source device that consists of white light source (11) and parabolic reflector (12) are cut by prepolarizer (51). Because IR coating that reflects infrared light is applied to the optical plane of incidental side of this prepolarizer, infrared ray is cut as well. The luminous flux (52) that passes through prepolarizer (51) is passed through light valve comprising polarization panels (53), (55), and transmission type liquid crystal panel (54); and becomes luminous flux that includes projected image information. As luminous flux (52) hardly includes s-polarized lights, the light that is absorbed by polarization panel (53) remains fairly small; and therefore, temperature rise on polarization panel (53) or liquid crystal panel that is arranged nearby remains fairly small to result in easy cooling of polarization panels (53), (55) and liquid crystal panel (54). The luminous flux that is passed through light valve is enlarged and projected by a projection lens (57); and a projected image is displayed on a screen (58). Although this case describes monochrome constitution, it is possible to display a colored projected image by separating lights of light source to three primary color lights through arrangement of colored light separator between prepolarizer (51) and polarization panel (53), and by modulating each with light valve and synthesizing to project.

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[illegible]
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proceeding direction. In addition, when slight tapered angle is applied to above-explained plate glasses, proceeding direction of s-polarized lights which are transmitted through repeat reflection changes to improve degree of polarization at the end.

[Examples]

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[Effects of this invention]
As explained above, according to this invention, through structuring the prepolarizer of polarizing light source device with prisms and plate glasses, setting angle of plate glasses becomes smaller than the case that does not use prisms; and displays effects of reduced working distance and effect of size reduction of polarizing light source device. In addition, because proceeding direction of luminous flux hardly changes by prepolarizer, hardly any loss of quantity of light occurs.

BRIEF EXPLANATION OF THE FIGURES

Figure 1 illustrates a constitutional plane view of one example of this polarizing light source device.

Figure 2 illustrates a plane view of constitution of conventional polarizing light source device.

Figure 3 illustrates a plane view of behavior of proceeding beam in a prepolarizer.

Figure 4 illustrates a plane view of behavior of proceeding beam within a prepolarizer when plate glasses of prepolarizer are tapered.

Figure 5 illustrates a constitutional diagonal view of projection type liquid crystal display device that is constructed by using this invention's polarizing light source device.

11.... white light source lamp
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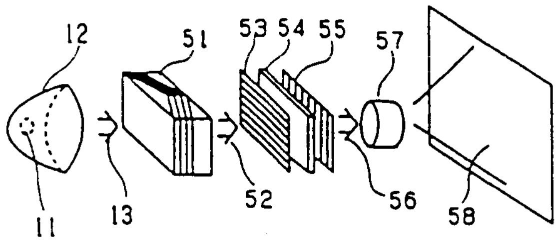
14.... prism
15.... plate glass
21.... prepolarizer
53,55... polarization panel
54... liquid crystal panel
57... projection lens
58... screen



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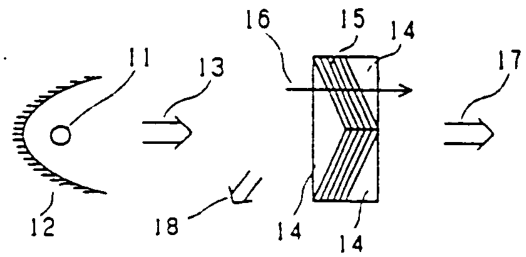

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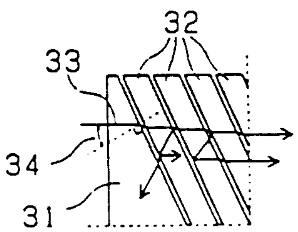

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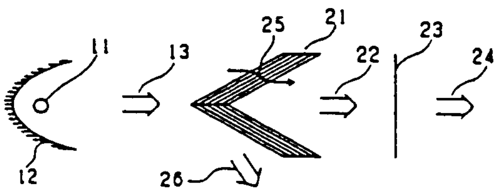

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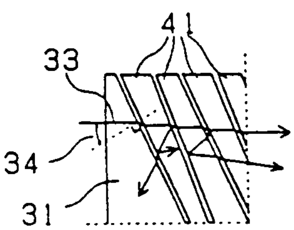

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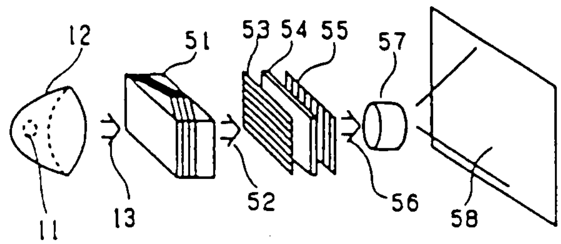

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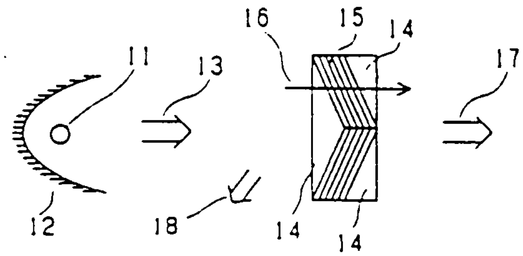

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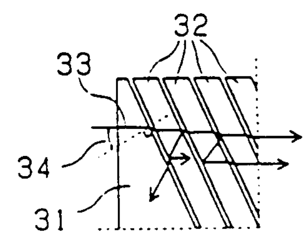

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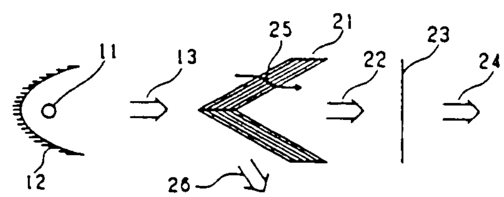

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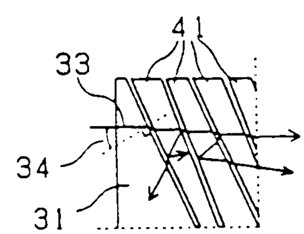

第4図

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Translation by: Mie N. Arntson, 512-331-7167